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Aural-Nondetectability Model Predictions for Night-Vision Goggles across Ambient Lighting Conditions

by Jeremy Gaston, Ashley Foots, Christopher Stachowiak, and Samantha Chambers

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14. ABSTRACT
This study evaluates 6 different night-vision goggles (NVGs) to determine if the devices meet the Level II aural-nondetectability standards of MIL-STD-1474E for a detection distance of 10 meters. These systems were tested while mounted on an Advanced Combat Helmet placed on the Knowles Electronic Manikin for Acoustic Research Auditory Test Fixture in an anechoic chamber at the US Army Research Laboratory. All NVG tests were conducted in the "automatic gain control" mode of operation for each system, and measurements were made at 4 locations around the devices. The results of the testing revealed that all systems passed the aural-nondetectability criteria of 10 m across the 3 tested lighting conditions.

15. SUBJECT TERMS
auditory detection, acoustic measurement, aural nondetectability, night-vision goggles

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1. Introduction

In the development of Army materiel, an important consideration is the acoustic output in different operational modes. In many operational contexts, stealth is required, and this can be especially true during low-light night operations when night-vision goggles (NVGs) may be used. The present work by the US Army Research Laboratory (ARL) measures the acoustic output of 6 NVGs under 3 different lighting conditions that approximate starlight, half-moon, and room light. All of these devices operate in a linear mode under low-light conditions (no active gating to limit incoming light levels), and have an automatic gain control (AGC). Active gating limits incoming light levels to protect the image intensifier tube if exposed to intense light. There have been a number of anecdotal reports of an audible tone produced by various NVGs when AGC has been activated, and at least one objective account of the PVS-7D NVG producing a tone predicted to be detectable at a distance of greater than 10 meters (m) (Gaston et al. 2013). Recent advances in NVG technology include changing to a white P45 phosphor instead of the more traditional green P43 phosphor and the use of high figure of merit (FOM) tubes. High-FOM as well as low-FOM tubes of both white and green phosphor were evaluated to document changes to the acoustical output. The present evaluation measures the acoustic output of 6 NVGs and evaluates the aural nondetectability of the devices as described in the Department of Defense (DOD) standard, MIL-STD-1474E. The criteria outlined in MIL-STD-1474E (DOD 2015) are based on a subset of parameters of the Auditory Detection Model (ADM) (Garinther et al 1985), which takes into account parameters such as human-hearing thresholds, atmospheric effects on acoustic propagation, ground reflectivity, average spectrum of ambient background noise, and average spectrum of the sound-producing object in predicting human detection distances. All of these factors affect the signal-to-noise ratio (SNR) of the sound-producing object relative to the ambient background noise at an observer's position. Gaston et al. (2013) describes in detail the relationship of the ADM model to human sound-detection performance.

1.1 NVG Systems

The night-vision technology used for this research is a high-FOM, NVG tube placed in the housing of an AN/PVS-23 (Model F5060RG). The FOM measure was implemented by the United States in 2001 as a way to classify the release of new night-vision technology (Bialos and Stuart 2005). Previously, NVGs were released by generation (Bialos and Stuart 2005; Chrzanowski 2013). FOM is a measure derived from the resolution in line pairs per millimeter and SNR of the NVG tube's

performance. This new FOM system is expected to ensure US forces maintain an advantage in NVG technology.

The rating for the low-FOM tubes evaluated for this report was about 1,800. The nominal rating for the high-FOM tubes was about 2,400. All of the NVGs had a field of view of 40° and magnification of 1×.

1.2 Aural Nondetectability: MIL-STD-1474E

The present study evaluates the aural nondetectability of the 6 NVG devices in Table 1. Aural nondetectability requirements are outlined in MIL-STD-1474E, and the requirements assume a set of default input parameters. The default temperature was selected to be 15 °C, the default humidity was selected to be 70%, and the default ground reflectivity was selected to be consistent with grass. Tables were developed for each system to be evaluated for aural nondetectability using Level II requirements, representing the quietest noise environment likely to be encountered: at least 16 kilometers away from road traffic and no insect noise. These background levels were taken from Environmental Protection Agency measurements (1971); the Level II measurements were made at the north rim of the Grand Canyon. The tables in MIL-STD-1474E list the detection limits in 1/3-octave bands for a number of distances as a function of various measurement distances. In the present study, predicted listener detection at a distance of no greater than 10 m was used as a criterion. This was evaluated in the context of Level II ambient background levels and given a microphone measurement distance of 1 m. This measurement distance is half of the distance listed in MIL-STD-1474E; thus, the data were run through the full ADM model to arrive at the predicted detection distances. The ADM was run using an Excel-based implementation of the model, using parameters described in Garinther et al. (1985).

Table 1 NVG classifications

Goggle identification	Phosphor color	Phosphor FOM
485W	White	Low
455G	Green	Low
214W	White	High
222W	White	High
610G	Green	High
614G	Green	High

2. Method

2.1 Location

2.1.1 Anechoic Chamber

All acoustic testing was conducted in the Anechoic Chamber of ARL's auditory facilities in Bldg. 520 at Aberdeen Proving Ground (APG), Maryland. Figure 1 shows the noise floor of the Anechoic Chamber on the day of testing in 1/3-octave bands compared with 1/3-octave band values of the Level II ambient-noise level described in MIL-STD-1474E.

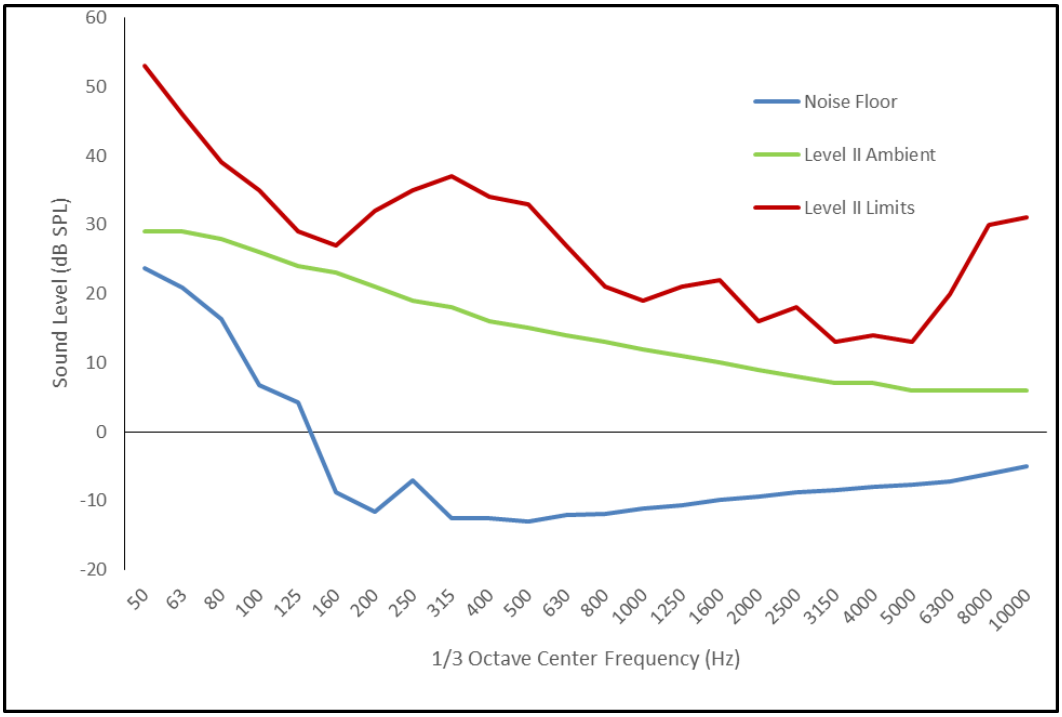

Fig. 1 Blue—Anechoic Chamber's noise floor in decibels (dB) referenced to sound pressure level (SPL); red—MIL-STD-1474E Level II ambient-noise floor; and green Level II limits in 1/3-octave band levels in hertz (Hz).

2.2 Apparatus and Procedure

2.2.1 Equipment

All recording procedures were conducted in accordance with the American National Standards Institute/Acoustical Society of America (ANSI/ASA) standard S1.13 (R2010) and DOD's MIL-STD-1474E. Recordings were made using the G.R.A.S. brand's 40HF-type 1-inch, low-noise, free-field microphone with

preamplifiers. Each microphone was powered by a low-noise G.R.A.S. 12HF power supply. Microphones were then connected to an RME-brand Fireface audio signal in–out (ASIO) device, which was connected to a laptop computer by firewire. All recordings (24 bit, 48 kHz) were acquired using Adobe Audition 3.0 recording software. The 40HF microphones were calibrated using a Bruel and Kajer calibrator set using a 1000-Hz tone at 94 dB SPL. The 6 NVGs described above were tested.

2.3 Recording Setup

To make measurements of the NVG devices, each system was first mounted on an Advanced Combat Helmet (ACH) that was placed on the Knowles Electronic Manikin for Acoustic Research (KEMAR) Acoustic Test Fixture (ATF), as shown in Fig. 2. Measurements were made from 4 microphone positions around the ATF. The 4 positions were 0°, 90°, 180°, and 270° relative to the facing of the ATF. The reference point for the 1-m measurement distance was always the center of the NVG device.

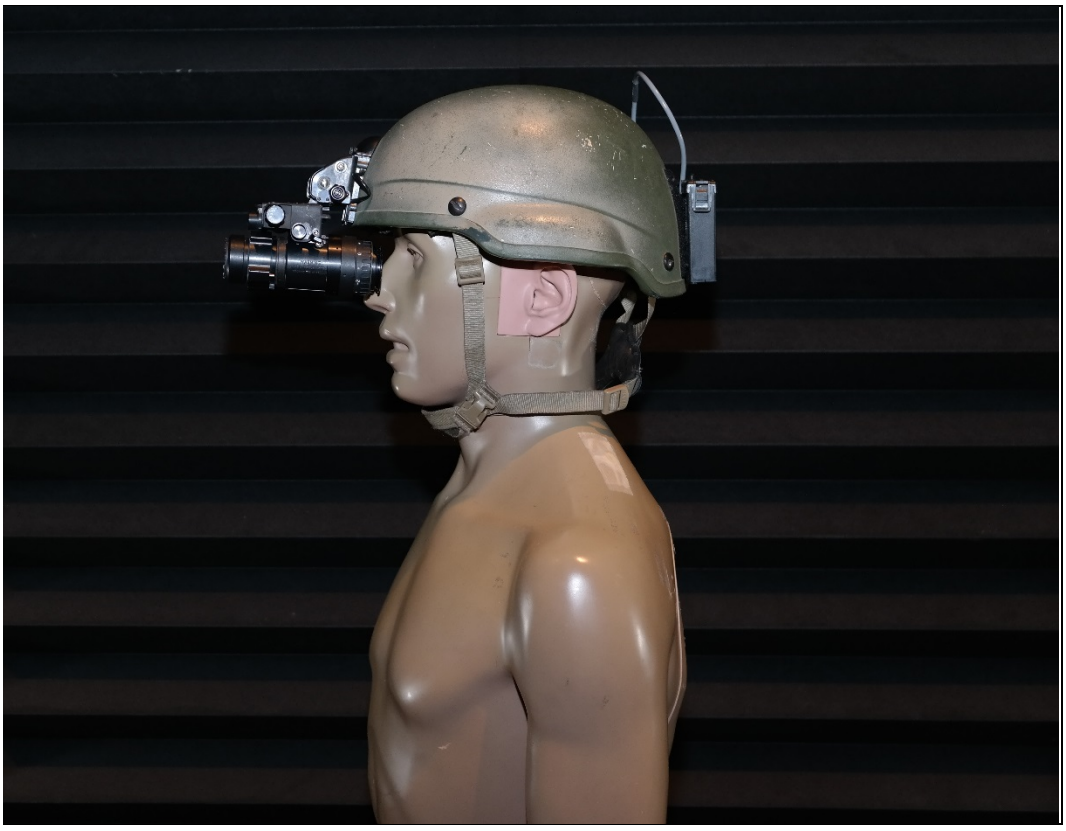

Fig. 2 Example of the test setup: NVGs were mounted to the KEMAR ATF and measurements made at 4 locations around the ATF using the 40HF measurement microphone.

Measurements were made at each of the 4 positions to evaluate the directivity of sound output for each device under the 3 approximate lighting conditions: 1) low, starlight; 2) mid, half-moon; and 3) high, room light. Although the absolute luminance approximated the specified lighting conditions, the spectra from the light-emitting diode (LED) and compact fluorescent light (CFL) sources may not be identical to the spectra of real-world lighting conditions. The center of the NVG device and the center of the 40HF microphone's diaphragm were set to 1.2 m above the floor of the anechoic chamber. For each measurement, at least 10 seconds (s) of sound data were collected for analysis. The test measurements, summarized in Table 2, show photopic data in footcandles (fc) and radiative data in watts per square meter (W/m^2).

Table 2 Light measurements

Description	Source	Photopic (fc)	Radiative units (W/m^2)	Radiative addition (W/m^2)
			Photopic only	Photopic+infrared
Starlight	LED	3.93E-06	6.19E-08	1.23E-07
Half-Moon	LED	3.40E-03	5.36E-05	2.31E-04
Room Lights	CFL + LED	555E+00	8.75E-02	4.40E-01

2.4 Measurement Conditions

Testing was conducted in one session. Before measurements were made, a calibration tone was recorded for the 40HF reference microphone. The calibration tone was used to calibrate the measured signals collected in the session. The first part of the session consisted of ambient measurements of APG's Anechoic Chamber to determine the noise floor and act as a reference for subsequent measurements of the NVGs. Measurements were then taken with each NVG mounted as in Fig. 2 from the 4 measurement locations in each of the 3 lighting conditions. A qualified engineer who was familiar with the systems controlled all operations of the NVGs. These systems have a simple "on" setting with AGC. The target being viewed was always the side wall of the Anechoic Chamber.

3. Results

3.1 General Analysis

All sound files were submitted to a 1/3-octave band analysis in MATLAB computing language. The design of the 1/3-octave filters was in accordance with ANSI/ASA S1.11 (2010). The analysis segmented the sound files into successive 250-millisecond-long windows. For each of these analysis windows, sound levels

were calculated for each 1/3 octave, each octave, and the overall level in dB SPL. Finally, the average level across at least 40 windows (10 s) was calculated for each 1/3 octave. These 1/3-octave values were then input into the ADM to estimate detection distances. Figure 1 summarized 1/3-octave band levels for ambient measurements by the 40HF microphones for the Anechoic Chamber; this characterized the noise floor of chamber during the measurement period. Figure 3 summarizes detection distances for each of the NVGs in each of the lighting levels. The Appendix's Tables A1–A18 summarize 1/3-octave band levels for each of the NVGs at each of the lighting levels. (In the bottom row of each Table the predicted detection distance—based on the model parameters outlined in this Section—are summarized; also, the predicted detection distances are rated "Go" or "No go" for meeting the 10-m Level II aural-nondetectability requirement.)

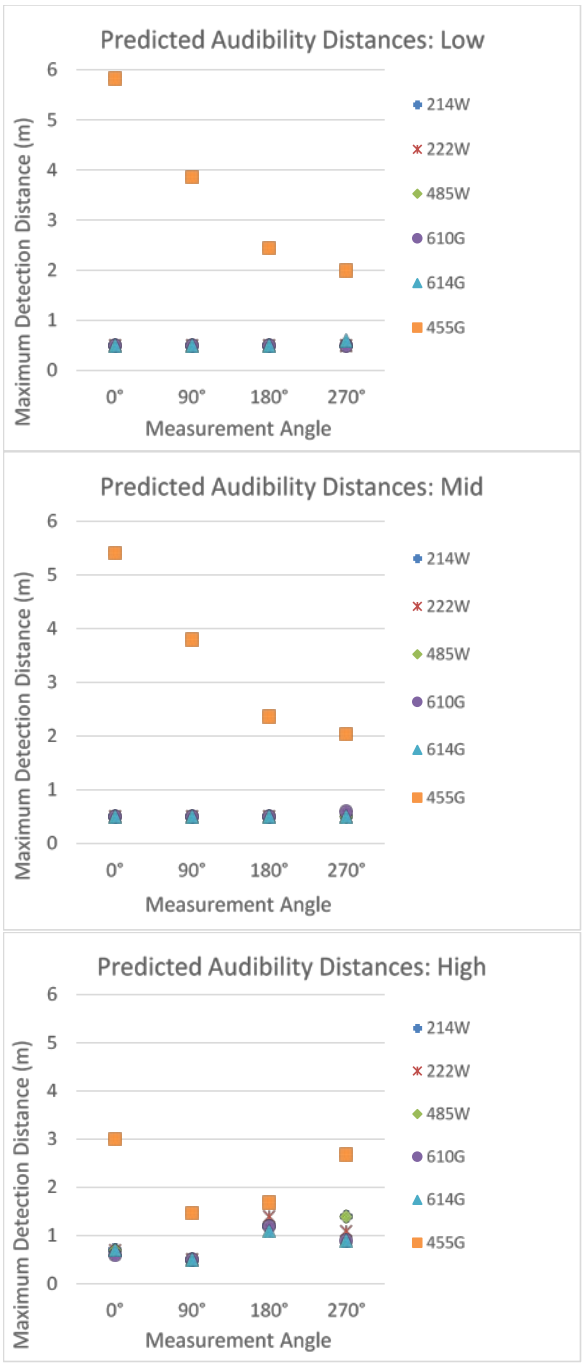

Fig. 3 Predicted audibility distances for each system as a function of lighting condition: Data are displayed separately for lighting conditions corresponding to low- (top panel), mid- (middle panel), and high-luminance (bottom) conditions.

All of the NVGs passed the Level II requirement for no auditory detection at any distance greater than 10 m at each of the lighting conditions. Almost all of the systems produced predicted detection distances of less than 2 m, much less than the 10-m limit described in MIL-STD-1474E. The one exception was the 455G system,

which was predicted to have a detection distance of up to 5.83 m (see Appendix Tables A-1 to A-18). Even so, the 455G system did not exceed the 10-m criterion.

In each of the 3 lighting conditions the 455G had an audible tone in the 2500-Hz–1/3-octave band, and the tone was always most intense directly in front of the device. Because of these elevated predicted-detection distances (relative to all of the other tested systems) and anecdotal reports by one of the authors that this system had a significant audible whine, an additional measurement was made. This measurement was made only for the front position with the facing wall's surface illuminated by a halogen lamp. This was a significantly brighter measurement condition but because it was a post hoc addition to testing, a light-level measurement was not collected. In this condition the audible whine was significantly more intense and produced a predicted detection distance of 15.6 m: much greater than the Level II limit of 10 m—but NVG systems are not typically used in very bright conditions.

4. Conclusions

In all measurement cases performed under relevant night-vision conditions, each of the NVGs passed the aural-nondetectability requirements outlined in MIL-STD-1474E. When the 455G system was additionally tested under very bright conditions, the provided 455G system produced a sound that could be aurally detected at a distance of 15.6 m, which is greater than the Level II limit of 10 m; but, this condition is not considered a normal NVG-use condition for the purposes of this evaluation.

In the past, there have been many anecdotal reports and objective reports (Gaston et al. 2013) of audible tones produced by some NVGs in AGC mode due to mechanical vibration produced by the autogating function of the image-intensifier tube. There are a number of potential causes of the vibration; however, not all image intensifiers produce significant vibration when in AGC mode. Indeed, in the evaluation of NVG performance, aural nondetectability has become an important requirement. As such, many vendors have taken action to reduce the potential of mechanical vibration by the image intensifier tubes in production. In the present case, each of the tested samples appeared to be sufficiently quiet in AGC mode to meet aural-nondetectability requirements.

Going forward, aural-nondetectability testing will continue to be an important aspect of characterization of system performance and can serve as a catalyst for improving component performance in NVG devices. In the present case, the Level II requirement used to evaluate predicted detection ranges represents the worst-case scenario for observer detection. In many practical situations, detection conditions

may be less ideal and would lead to much longer predicted-detection ranges. Current work in the authors' ARL laboratory has begun to characterize relevant real-world changes in ambient background noises and how those changes would affect human performance, such as the aural detection of sound sources.

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Appendix. Measurements at 3 Lighting Levels

Table A-1 Measurements for the 214W NVG in the "low" lighting level listing each 1/3-octave band level

Analyzed 1/3 octaves (Hz)	Measurement angle (°)			
	0	**90**	**180**	**270**
25	23.84	27.28	26.84	26.62
31.5	23.50	24.31	22.40	22.08
40	20.48	22.48	17.81	15.97
50	22.43	23.40	21.82	21.82
63	17.96	21.67	17.96	27.78
80	11.32	13.76	11.71	12.98
100	5.78	6.49	7.25	9.58
125	3.97	2.00	0.74	2.20
160	–8.72	–8.51	–8.02	–6.82
200	–9.12	–9.68	–10.16	–10.83
250	–0.83	–9.14	–2.93	–10.77
315	–11.97	–11.96	–12.00	–11.32
400	–12.33	–11.89	–12.02	–10.16
500	–12.38	–12.21	–12.15	–12.87
630	–11.97	–12.07	–11.49	–12.03
800	–11.68	–10.53	–11.51	–12.24
1000	–11.05	–10.82	–10.82	–11.52
1250	–10.49	–10.45	–10.31	–10.98
1600	–9.94	–9.83	–9.74	–10.49
2000	–9.42	–9.37	–9.18	–9.84
2500	–8.94	–8.84	–8.79	–9.16
3150	–8.56	–8.21	–8.39	–8.46
4000	–8.27	–7.85	–8.11	–8.11
5000	–7.90	–7.51	–7.80	–7.53
6300	–7.19	–7.06	–7.12	–6.97
8000	–6.06	–5.95	–6.08	–6.03
10000	–4.92	–4.99	–5.06	–5.01
12500	–4.03	–3.97	–4.04	–4.02
16000	–2.19	–2.19	–2.22	–2.17
20000	–0.74	–0.71	–0.80	1.30
Detection distance (m)	0.5	0.5	0.5	0.5
Go/No go	Go	Go	Go	Go

Note: The bottom 2 rows list predicted-detection distances from the ADM and whether the predicted distances meet Level II aural-nondetectability requirements outlined in MIL-STD-1474E. "Go" represents meeting the MIL-STD-1474E requirements and "No go" represents not meeting the MIL-STD-1474E requirements.

Table A-2 Measurements for the 214W NVG in the "mid" lighting level listing each 1/3-octave band level

Analyzed 1/3 octaves (Hz)	Measurement angle (°)			
	0	**90**	**180**	**270**
25	24.73	29.37	28.04	25.79
31.5	23.70	28.00	23.04	22.09
40	18.52	22.99	18.44	16.26
50	20.70	25.11	21.61	21.67
63	17.91	25.19	17.83	28.01
80	14.67	14.57	12.04	13.26
100	5.59	7.58	7.40	11.78
125	3.77	3.91	0.76	5.11
160	–5.24	–7.40	–7.84	–1.15
200	–6.23	–10.93	–10.56	–2.26
250	–0.47	–8.04	–2.86	–8.06
315	–8.91	–11.95	–12.28	–9.53
400	–9.12	–11.85	–12.62	–9.02
500	–9.99	–12.33	–12.24	–10.52
630	–10.59	–12.24	–11.71	–10.48
800	–10.63	–11.10	–11.76	–11.41
1000	–10.36	–11.20	–11.11	–11.04
1250	–10.16	–10.80	–10.57	–10.67
1600	–9.79	–10.08	–10.03	–10.20
2000	–9.36	–9.46	–9.46	–9.47
2500	–8.98	–8.80	–8.97	–8.86
3150	–8.54	–8.11	–8.42	–8.35
4000	–8.31	–7.73	–7.90	–7.82
5000	–7.85	–7.30	–7.49	–7.55
6300	–7.12	–6.82	–7.08	–7.01
8000	–6.07	–5.86	–5.95	–6.00
10000	–4.83	–4.94	–5.05	–5.04
12500	–4.05	–3.98	–4.01	–4.00
16000	–2.23	–2.17	–2.20	–2.17
20000	–0.82	–0.80	–0.85	–0.64
Detection distance (m)	0.5	0.5	0.5	0.5
Go/No go	Go	Go	Go	Go

Note: The bottom 2 rows list predicted-detection distances from the ADM and whether the predicted distances meet Level II aural-nondetectability requirements outlined in MIL-STD-1474E. "Go" represents meeting the MIL-STD-1474E requirements and "No go" represents not meeting the MIL-STD-1474E requirements.

Table A-3 Measurements for the 214W NVG in the "high" lighting level listing each 1/3-octave band level

Analyzed 1/3 octaves (Hz)	Measurement angle (°)			
	0	**90**	**180**	**270**
25	30.02	27.26	28.01	29.03
31.5	25.01	27.08	23.00	22.57
40	20.25	22.77	17.72	16.11
50	22.67	24.98	20.87	21.81
63	18.85	24.95	16.59	28.07
80	12.38	14.49	11.42	13.13
100	11.60	7.29	7.30	10.14
125	7.88	3.75	1.09	2.44
160	–2.37	–7.85	–8.03	–6.76
200	–1.38	–10.99	–10.73	–10.11
250	1.11	–7.39	–2.94	–11.18
315	–7.68	–12.47	–12.95	–11.79
400	–8.83	–12.32	–13.22	–11.72
500	–9.72	–12.39	–10.99	–11.99
630	–9.18	–8.94	–4.91	–3.76
800	–0.45	–3.87	–2.04	0.38
1000	–8.07	–9.54	–3.45	–4.69
1250	–10.71	–10.13	–9.35	–8.54
1600	–9.54	–9.74	–7.35	–6.44
2000	–2.87	–5.35	4.26	3.43
2500	–2.03	–5.73	–4.21	–1.29
3150	–7.26	–7.37	–4.59	–4.48
4000	–3.61	–5.42	2.86	–2.57
5000	–5.27	–6.87	–4.97	–5.74
6300	–2.82	–6.32	–5.37	–2.25
8000	–4.67	–5.12	–3.29	–2.47
10000	–4.44	–4.81	–4.30	–4.16
12500	–3.66	–3.89	–3.76	–3.46
16000	–2.09	–2.19	–2.13	–2.14
20000	–0.77	–0.83	–0.88	–0.75
Detection distance (m)	0.7	0.5	1.2	1.4
Go/No go	Go	Go	Go	Go

Note: The bottom 2 rows list predicted-detection distances from the ADM and whether the predicted distances meet Level II aural-nondetectability requirements outlined in MIL-STD-1474E. "Go" represents meeting the MIL-STD-1474E requirements and "No go" represents not meeting the MIL-STD-1474E requirements.

Table A-4 Measurements for the 222W NVG in the "low" lighting level listing each 1/3-octave band level

Analyzed 1/3 octaves (Hz)	Measurement angle (°)			
	0	**90**	**180**	**270**
25	28.70	30.43	26.37	27.66
31.5	28.57	28.06	25.79	22.35
40	20.36	23.73	18.11	15.90
50	22.60	25.44	22.58	19.53
63	20.34	25.19	21.60	16.31
80	14.88	15.19	11.74	12.83
100	4.94	7.66	7.68	10.05
125	4.21	2.56	1.32	3.61
160	–6.32	–7.54	–8.25	–5.24
200	–4.55	–11.13	–10.42	–8.12
250	–0.73	–9.12	–3.74	–8.77
315	–9.91	–12.07	–12.57	–10.40
400	–9.72	–12.28	–12.64	–9.51
500	–10.64	–12.29	–12.16	–12.04
630	–11.04	–12.30	–11.67	–11.46
800	–11.30	–11.12	–11.59	–11.57
1000	–10.91	–11.14	–10.98	–10.77
1250	–10.67	–10.68	–10.47	–10.70
1600	–10.14	–10.11	–9.91	–10.04
2000	–9.46	–9.49	–9.36	–9.47
2500	–8.45	–8.86	–8.87	–8.88
3150	–6.51	–8.22	–8.39	–8.18
4000	–7.93	–7.90	–8.16	–8.02
5000	-7.52	-7.41	-7.75	–7.66
6300	–6.86	–6.87	–7.12	–7.04
8000	–5.94	–5.92	–6.07	–5.99
10000	–5.01	–4.97	–5.08	–4.99
12500	–3.99	–3.95	–4.07	–4.02
16000	–2.22	–2.19	–2.20	–2.21
20000	–0.67	–0.77	–0.84	–0.83
Detection distance (m)	0.5	0.5	0.5	0.5
Go/No go	Go	Go	Go	Go

Note: The bottom 2 rows list predicted-detection distances from the ADM and whether the predicted distances meet Level II aural-nondetectability requirements outlined in MIL-STD-1474E. "Go" represents meeting the MIL-STD-1474E requirements and "No go" represents not meeting the MIL-STD-1474E requirements.

Table A-5 Measurements for the 222W NVG in the "mid" lighting level listing each 1/3-octave band level

Analyzed 1/3 octaves (Hz)	Measurement angle (°)			
	0	**90**	**180**	**270**
25	27.89	30.11	30.98	27.31
31.5	28.68	28.05	25.68	22.07
40	22.64	21.85	18.81	16.66
50	24.06	24.77	21.98	20.22
63	20.85	24.78	22.62	16.32
80	15.95	14.44	11.72	12.78
100	9.43	6.96	8.11	10.83
125	6.29	0.26	1.03	3.87
160	–3.28	–6.99	–7.94	–3.32
200	–3.81	–9.32	–10.02	–1.22
250	–0.04	–8.82	–4.08	–6.37
315	–9.62	–10.55	–11.95	–9.85
400	–9.06	–10.85	–12.21	–7.62
500	–9.49	–11.43	–12.17	–10.39
630	–11.44	–11.53	–11.51	–10.63
800	–11.69	–10.66	–11.85	–11.40
1000	–11.02	–10.91	–11.05	–10.85
1250	–10.80	–10.61	–10.66	–10.64
1600	–10.04	–10.17	–10.04	–10.10
2000	–9.48	–9.57	–9.42	–9.53
2500	–8.32	–8.76	–8.70	–8.68
3150	–6.15	–7.80	–8.12	–7.59
4000	–7.89	–7.72	–7.79	–8.12
5000	–7.48	–7.29	–7.54	–7.76
6300	–6.98	–6.78	–6.95	–7.13
8000	–5.95	–5.86	–5.91	–5.99
10000	–4.98	–5.01	–5.01	–5.05
12500	–4.01	–4.02	–3.99	–4.03
16000	–2.17	–2.23	–2.20	–2.21
20000	–0.73	–0.85	–0.84	–0.81
Detection distance (m)	0.5	0.5	0.5	0.5
Go/No go	Go	Go	Go	Go

Note: The bottom 2 rows list predicted-detection distances from the ADM and whether the predicted distances meet Level II aural-nondetectability requirements outlined in MIL-STD-1474E. "Go" represents meeting the MIL-STD-1474E requirements and "No go" represents not meeting the MIL-STD-1474E requirements.

Table A-6 Measurements for the 222W NVG in the "high" lighting level listing each 1/3-octave band level

Analyzed 1/3 octaves (Hz)	Measurement angle (°)			
	0	**90**	**180**	**270**
25	26.35	28.12	27.01	26.44
31.5	24.71	27.59	24.25	21.42
40	20.30	22.21	18.03	16.14
50	23.48	24.86	22.97	19.52
63	18.34	24.48	22.33	16.75
80	11.72	14.44	11.52	12.98
100	5.89	6.58	8.05	12.32
125	3.27	0.77	0.97	5.40
160	–8.32	–7.16	–8.15	–0.97
200	–8.84	–10.00	–11.18	–1.99
250	–0.54	–8.79	–4.09	–6.74
315	–11.66	–11.16	–13.03	–9.43
400	–12.21	–10.98	–13.01	–9.70
500	–12.22	–11.78	–11.00	–9.64
630	–10.36	–8.84	–5.28	–3.12
800	–4.22	–2.42	–2.24	0.27
1000	–10.42	–7.86	–3.06	–4.13
1250	–11.04	–10.19	–9.91	–8.40
1600	–9.28	–9.66	–8.59	–6.27
2000	–1.58	–6.18	1.16	3.56
2500	–1.31	–5.57	–4.46	–0.29
3150	–7.49	–7.65	–4.48	–4.90
4000	–4.42	–6.56	2.28	–3.25
5000	–5.36	–7.04	–4.74	–5.71
6300	–4.45	–6.47	–5.52	–3.30
8000	–5.12	–5.42	–2.92	–3.23
10000	–4.65	–4.98	–4.40	–4.30
12500	–3.79	–3.99	–3.75	–3.51
16000	–2.17	–2.22	–2.08	–2.09
20000	–0.72	–0.87	–0.85	–0.79
Detection distance (m)	0.7	0.5	1.4	1.1
Go/No go	Go	Go	Go	Go

Note: The bottom 2 rows list predicted-detection distances from the ADM and whether the predicted distances meet Level II aural-nondetectability requirements outlined in MIL-STD-1474E. "Go" represents meeting the MIL-STD-1474E requirements and "No go" represents not meeting the MIL-STD-1474E requirements.

Table A-7 Measurements for the 485W NVG in the "low" lighting level listing each 1/3-octave band level

Analyzed 1/3 octaves (Hz)	Measurement angle (°)			
	0	**90**	**180**	**270**
25	25.82	25.81	27.57	25.48
31.5	24.38	23.04	22.82	24.29
40	20.11	22.50	18.41	16.47
50	23.15	23.31	21.19	18.50
63	19.21	19.59	18.35	15.13
80	15.19	13.26	10.71	11.22
100	8.84	6.74	6.89	17.16
125	4.76	1.28	0.54	10.53
160	–6.37	–8.19	–8.04	–0.82
200	–5.97	–10.83	–9.75	–1.27
250	–0.14	–8.06	–2.20	–3.50
315	–10.17	–12.11	–12.14	–7.17
400	–10.20	–12.06	–12.56	–6.43
500	–11.21	–12.46	–12.13	–8.77
630	–11.86	–12.22	–11.47	–10.52
800	–11.58	–11.03	–11.92	–10.80
1000	–10.93	–11.18	–11.31	–10.36
1250	–10.61	–10.73	–10.81	–10.37
1600	–9.88	–10.14	–10.24	–9.82
2000	–9.30	–9.48	–9.56	–9.31
2500	–8.80	–8.79	–8.85	–8.80
3150	–8.31	–8.04	–8.31	–8.32
4000	–8.05	–7.84	–7.84	–7.87
5000	–7.73	–7.45	–7.30	–7.67
6300	–7.14	–6.89	–6.80	–7.09
8000	–6.02	–5.89	–5.81	–6.01
10000	–5.00	–5.04	–4.96	–5.02
12500	–3.97	–4.02	–3.99	–4.06
16000	–2.17	–2.20	–2.15	–2.22
20000	–0.77	–0.86	–0.89	–0.78
Detection distance (m)	0.5	0.5	0.5	0.5
Go/No go	Go	Go	Go	Go

Note: The bottom 2 rows list predicted-detection distances from the ADM and whether the predicted distances meet Level II aural-nondetectability requirements outlined in MIL-STD-1474E. "Go" represents meeting the MIL-STD-1474E requirements and "No go" represents not meeting the MIL-STD-1474E requirements.

Table A-8 Measurements for the 485W NVG in the "mid" lighting level listing each 1/3-octave band level

Analyzed 1/3 octaves (Hz)	Measurement angle (°)			
	0	**90**	**180**	**270**
25	28.44	28.05	26.40	24.85
31.5	24.94	24.32	22.40	20.95
40	20.09	23.06	17.79	15.90
50	22.83	22.92	21.20	19.74
63	18.45	21.01	18.13	15.02
80	11.50	13.13	10.70	13.55
100	7.55	6.55	6.80	18.57
125	4.76	1.00	0.93	14.67
160	–6.75	–8.78	–8.41	3.87
200	–6.77	–11.25	–10.39	0.89
250	–1.34	–8.50	–3.30	–2.41
315	–10.55	–12.39	–12.41	–5.37
400	–11.26	–12.31	–12.59	–2.62
500	–11.90	–12.66	–12.25	–5.14
630	–11.56	–12.66	–11.51	–8.07
800	–11.69	–11.29	–11.86	–9.19
1000	–11.30	–11.50	–11.23	–8.84
1250	–10.74	–11.00	–10.64	–9.62
1600	–10.15	–10.26	–10.01	–9.43
2000	–9.55	–9.66	–9.27	–9.33
2500	–8.80	–8.99	–8.79	–8.79
3150	–8.28	–8.18	–8.43	–8.34
4000	–7.82	–7.71	–7.98	–7.91
5000	–7.41	–7.23	–7.59	–7.54
6300	–6.80	–6.62	–7.10	–6.99
8000	–5.79	–5.75	–5.95	–5.94
10000	–4.91	–4.90	–5.03	–4.95
12500	–3.94	–3.95	–4.01	–4.02
16000	–2.15	–2.18	–2.22	–2.20
20000	–0.81	–0.82	–0.83	–0.79
Detection distance (m)	0.5	0.5	0.5	0.5
Go/No go	Go	Go	Go	Go

Note: The bottom 2 rows list predicted-detection distances from the ADM and whether the predicted distances meet Level II aural-nondetectability requirements outlined in MIL-STD-1474E. "Go" represents meeting the MIL-STD-1474E requirements and "No go" represents not meeting the MIL-STD-1474E requirements.

Table A-9 Measurements for the 485W NVG in the "high" lighting level listing each 1/3-octave band level

Analyzed 1/3 octaves (Hz)	Measurement angle (°)			
	0	**90**	**180**	**270**
25	27.60	30.62	28.12	25.11
31.5	25.36	24.69	24.57	21.63
40	20.53	22.25	18.93	15.42
50	23.18	23.06	22.32	19.66
63	19.59	21.41	19.20	15.67
80	12.17	13.50	11.24	12.46
100	7.61	6.69	7.24	12.00
125	5.39	1.30	1.16	5.02
160	–5.46	–8.33	–8.09	–4.39
200	–4.99	–10.81	–10.14	–7.12
250	–0.64	–8.46	–3.10	–8.13
315	–9.78	–11.82	–12.93	–10.16
400	–10.91	–12.08	–13.09	–9.25
500	–10.87	–12.46	–10.86	–10.64
630	–10.01	–8.88	–5.12	–3.38
800	–5.33	–3.12	–1.63	–3.68
1000	–7.37	–9.07	–2.51	–3.76
1250	–9.00	–10.41	–10.07	–8.01
1600	–9.12	–10.02	–9.14	–4.86
2000	–0.20	–6.83	–0.89	6.01
2500	–2.07	–5.61	–5.08	0.39
3150	–5.89	–7.39	–4.43	–5.16
4000	–4.14	–5.70	0.98	–3.87
5000	–5.35	–6.75	–5.60	–5.04
6300	–4.43	–6.24	–5.74	–2.58
8000	–4.81	–5.11	–3.11	–3.21
10000	–4.40	–4.75	–4.50	–4.29
12500	–3.65	–3.88	–3.83	–3.54
16000	–2.03	–2.23	–2.15	–2.09
20000	–0.71	–0.89	–0.90	–0.79
Detection distance (m)	0.7	0.5	1.2	1.4
Go/No go	Go	Go	Go	Go

Note: The bottom 2 rows list predicted-detection distances from the ADM and whether the predicted distances meet Level II aural-nondetectability requirements outlined in MIL-STD-1474E. "Go" represents meeting the MIL-STD-1474E requirements and "No go" represents not meeting the MIL-STD-1474E requirements.

Table A-10 Measurements for the 610G NVG in the "low" lighting level listing each 1/3-octave band level

Analyzed 1/3 octaves (Hz)	Measurement angle (°)			
	0	**90**	**180**	**270**
25	30.04	26.56	26.40	28.33
31.5	26.73	23.78	25.08	22.38
40	21.66	20.70	18.01	16.54
50	22.58	23.19	22.60	22.30
63	19.26	24.22	21.67	27.37
80	15.24	13.69	11.77	13.57
100	9.22	6.91	7.66	10.93
125	5.87	5.83	1.09	4.14
160	–4.92	–7.44	–7.82	–4.39
200	–4.80	–9.65	–9.90	–8.83
250	0.24	–8.29	–3.16	–8.64
315	–9.44	–11.01	–11.95	–10.92
400	–9.81	–11.04	–12.41	–10.03
500	–10.93	–11.64	–11.87	–12.27
630	–11.53	–11.58	–11.43	–11.46
800	–11.72	–10.61	–11.26	–11.82
1000	–11.12	–10.85	–10.85	–11.26
1250	–10.78	–10.30	–10.35	–10.97
1600	–10.19	–9.76	–9.95	–10.14
2000	–9.55	–9.39	–9.29	–9.41
2500	–8.42	–8.75	–8.73	–8.67
3150	–8.36	–8.53	–8.38	–8.22
4000	–7.83	–8.21	–8.14	–7.87
5000	–7.44	–7.81	–7.84	–7.60
6300	–6.88	–7.27	–7.14	–7.05
8000	–5.82	–6.08	–6.01	–6.01
10000	–4.97	–5.12	–5.05	–5.01
12500	–4.00	–4.05	–4.03	–4.00
16000	–2.19	–2.23	–2.24	–2.17
20000	–0.85	–0.87	–0.84	–0.82
Detection distance (m)	0.5	0.5	0.5	0.5
Go/No go	Go	Go	Go	Go

Note: The bottom 2 rows list predicted-detection distances from the ADM and whether the predicted distances meet Level II aural-nondetectability requirements outlined in MIL-STD-1474E. "Go" represents meeting the MIL-STD-1474E requirements and "No go" represents not meeting the MIL-STD-1474E requirements.

Table A-11 Measurements for the 610G NVG in the "mid" lighting level listing each 1/3-octave band level

Analyzed 1/3 octaves (Hz)	Measurement angle (°)			
	0	**90**	**180**	**270**
25	30.13	25.56	26.45	29.97
31.5	26.56	23.57	24.47	22.96
40	21.97	22.01	19.01	16.59
50	23.49	23.25	23.18	22.27
63	19.43	20.20	22.86	27.57
80	16.05	14.11	11.37	14.48
100	9.69	6.34	7.89	16.86
125	6.10	–0.77	1.19	7.78
160	–1.34	–8.22	–7.79	–3.26
200	–1.94	–10.77	–9.66	2.10
250	0.36	–9.16	–2.30	–4.34
315	–7.16	–11.84	–12.17	–8.30
400	–6.44	–11.84	–12.41	–6.36
500	–8.62	–12.18	–11.96	–9.59
630	–11.01	–12.10	–11.55	–10.50
800	–11.38	–11.03	–11.58	–11.17
1000	–10.98	–11.10	–11.14	–10.84
1250	–10.78	–10.55	–10.55	–10.82
1600	–10.28	–9.82	–9.93	–10.12
2000	–9.64	–9.33	–9.30	–9.55
2500	–8.38	–8.65	–8.76	–8.61
3150	–8.44	–8.36	–8.32	–8.25
4000	–7.89	–8.07	–8.02	–7.83
5000	–7.44	–7.78	–7.68	–7.42
6300	–6.85	–7.17	–7.12	–6.87
8000	–5.90	–6.06	–5.99	–5.91
10000	–4.98	–4.98	–5.02	–4.91
12500	–4.00	–4.03	–3.97	–3.96
16000	–2.22	–2.20	–2.19	–2.21
20000	–0.85	–0.82	–0.82	–0.81
Detection distance (m)	0.5	0.5	0.5	0.6
Go/No go	Go	Go	Go	Go

Note: The bottom 2 rows list predicted-detection distances from the ADM and whether the predicted distances meet Level II aural-nondetectability requirements outlined in MIL-STD-1474E. "Go" represents meeting the MIL-STD-1474E requirements and "No go" represents not meeting the MIL-STD-1474E requirements.

Table A-12 Measurements for the 610G NVG in the "high" lighting level listing each 1/3-octave band level

Analyzed 1/3 octaves (Hz)	Measurement angle (°)			
	0	**90**	**180**	**270**
25	25.55	30.44	27.23	28.46
31.5	27.19	24.55	25.21	24.01
40	20.40	22.41	18.37	17.90
50	23.30	23.70	22.80	22.40
63	21.98	20.57	21.62	27.04
80	12.85	14.77	11.94	14.13
100	8.30	7.55	8.10	11.59
125	4.87	0.24	1.47	4.96
160	–5.35	–8.21	–7.80	–1.35
200	–5.08	–11.39	–9.83	–3.75
250	–0.27	–9.60	–2.29	–7.08
315	–9.40	–12.24	–12.49	–9.82
400	–9.65	–11.96	–12.56	–10.39
500	–11.31	–12.60	–10.61	–9.92
630	–10.93	–9.18	–5.17	–3.13
800	–5.92	–3.67	–2.29	1.02
1000	–10.55	–9.36	–3.14	–3.16
1250	–10.98	–10.42	–10.03	–9.41
1600	–9.14	–10.04	–8.94	–6.80
2000	–1.21	–6.82	0.33	2.10
2500	–2.39	–5.72	–4.85	–0.96
3150	–7.77	–7.39	–4.25	–4.71
4000	–4.27	–5.69	1.53	–3.22
5000	–5.49	–6.84	–4.93	–5.86
6300	–4.08	–6.34	–5.53	–4.46
8000	–5.23	–5.23	–2.73	–4.05
10000	–4.71	–4.82	–4.36	–4.52
12500	–3.81	–3.94	–3.75	–3.74
16000	–2.15	–2.19	–2.16	–2.15
20000	–0.82	–0.84	–0.85	–0.82
Detection distance (m)	0.6	0.5	1.2	0.9
Go/No go	Go	Go	Go	Go

Note: The bottom 2 rows list predicted-detection distances from the ADM and whether the predicted distances meet Level II aural-nondetectability requirements outlined in MIL-STD-1474E. "Go" represents meeting the MIL-STD-1474E requirements and "No go" represents not meeting the MIL-STD-1474E requirements.

Table A-13 Measurements for the 614G NVG in the "low" lighting level listing each 1/3-octave band level

Analyzed 1/3 octaves (Hz)	Measurement angle (°)			
	0	**90**	**180**	**270**
25	26.18	27.35	28.51253	24.25
31.5	25.82	24.97	25.8343	21.81
40	20.41	22.16	18.70611	16.29
50	23.25	23.39	22.76264	22.05
63	21.24	21.04	21.42876	27.30
80	15.20	14.21	11.58648	13.41
100	6.85	7.06	7.519631	14.61
125	4.30	1.60	1.609789	5.92
160	–7.30	–8.08	–7.9129	1.93
200	–9.15	–11.04	–9.62275	6.99
250	–0.54	–9.18	–2.72212	–2.60
315	–12.02	–11.99	–11.9807	–5.74
400	–12.40	–12.28	–12.1813	–5.13
500	–12.58	–12.40	–11.9835	–5.55
630	–12.12	–12.34	–11.4401	–9.00
800	–11.70	–11.15	–11.6043	–9.52
1000	–11.22	–11.23	–11.064	–10.52
1250	–10.82	–10.76	–10.6467	–10.50
1600	–10.05	–10.21	–10.1276	–9.88
2000	–9.39	–9.53	–9.4571	–9.42
2500	–8.82	–8.86	–8.80942	–8.76
3150	–8.36	–8.28	–8.28067	–8.21
4000	–7.98	–7.85	–7.89134	–7.87
5000	–7.67	–7.51	–7.54385	–7.51
6300	–7.10	–6.93	–6.98745	–6.99
8000	–6.04	–5.96	–5.88983	–5.99
10000	–4.94	–4.99	–5.00579	–4.99
12500	–3.96	–3.95	–3.95663	–3.99
16000	–2.20	–2.16	–2.18448	–2.17
20000	–0.82	–0.81	–0.81631	–0.80
Detection distance (m)	0.5	0.5	0.5	0.6
Go/No go	Go	Go	Go	Go

Note: The bottom 2 rows list predicted-detection distances from the ADM and whether the predicted distances meet Level II aural-nondetectability requirements outlined in MIL-STD-1474E. "Go" represents meeting the MIL-STD-1474E requirements and "No go" represents not meeting the MIL-STD-1474E requirements.

Table A-14 Measurements for the 614G NVG in the "mid" lighting level listing each 1/3-octave band level

Analyzed 1/3 octaves (Hz)	Measurement angle (°)			
	0	**90**	**180**	**270**
25	29.62	26.17	28.77	25.36
31.5	28.40	24.12	23.71	24.52
40	21.13	22.67	17.67	16.60
50	24.19	23.17	21.11	19.67
63	20.61	20.53	18.98	19.61
80	15.19	13.95	10.51	11.70
100	7.93	6.82	7.03	9.93
125	5.50	1.23	0.79	2.45
160	–4.96	–8.72	–8.07	–7.65
200	–4.49	–11.68	–9.96	–11.53
250	–0.03	–9.40	–2.75	–11.61
315	–10.56	–12.40	–12.27	–12.09
400	–8.62	–12.33	–12.56	–10.82
500	–9.22	–12.52	–12.26	–12.78
630	–11.47	–12.36	–11.53	–11.46
800	–11.25	–11.18	–11.75	–11.89
1000	–10.54	–11.34	–11.22	–11.06
1250	–10.82	–10.71	–10.67	–10.67
1600	–10.24	–10.09	–10.16	–9.96
2000	–9.58	–9.51	–9.56	–9.41
2500	–8.89	–8.92	–8.83	–8.94
3150	–8.40	–8.27	–8.22	–8.43
4000	–7.83	–7.78	–7.86	–8.21
5000	–7.48	–7.36	–7.50	–7.77
6300	–6.93	–6.88	–6.96	–7.22
8000	–5.96	–5.92	–5.99	–6.07
10000	–5.01	–4.98	–5.03	–5.07
12500	–4.02	–3.99	–4.00	–3.99
16000	–2.23	–2.16	–2.25	–2.17
20000	–0.83	–0.81	–0.87	–0.83
Detection distance (m)	0.5	0.5	0.5	0.5
Go/No go	Go	Go	Go	Go

Note: The bottom 2 rows list predicted-detection distances from the ADM and whether the predicted distances meet Level II aural-nondetectability requirements outlined in MIL-STD-1474E. "Go" represents meeting the MIL-STD-1474E requirements and "No go" represents not meeting the MIL-STD-1474E requirements.

Table A-15 Measurements for the 614G NVG in the "high" lighting level listing each 1/3-octave band level

Analyzed 1/3 octaves (Hz)	Measurement angle (°)			
	0	**90**	**180**	**270**
25	27.17	25.50	31.40	24.94
31.5	26.94	23.45	24.52	22.65
40	20.61	22.36	18.83	16.16
50	24.37	23.04	22.12	20.06
63	29.19	20.24	18.13	19.35
80	12.97	14.05	10.91	10.35
100	7.90	6.97	6.80	11.31
125	5.89	1.35	1.66	5.41
160	–4.76	–8.73	–7.62	–1.94
200	–5.26	–11.56	–9.69	–3.37
250	–0.17	–9.59	–2.66	–7.25
315	–9.34	–12.46	–12.10	–10.56
400	–10.24	–12.56	–12.50	–10.37
500	–11.40	–12.63	–10.78	–10.84
630	–10.90	–8.95	–5.60	–3.04
800	–6.40	–3.23	–1.45	0.07
1000	–10.41	–9.02	–2.56	–3.68
1250	–10.75	–10.35	–10.12	–8.84
1600	–9.23	–10.05	–9.26	–6.23
2000	–2.14	–6.40	–2.12	2.73
2500	–2.83	–5.65	–5.24	–0.22
3150	–7.65	–7.37	–4.42	–5.08
4000	–4.38	–5.61	0.49	–3.59
5000	–5.61	–6.84	–5.53	–5.96
6300	–3.53	–6.22	–5.38	–4.06
8000	–5.08	–5.24	–3.54	–3.97
10000	–4.30	–4.82	–4.55	–4.44
12500	–3.79	–3.98	–3.82	–3.69
16000	–2.17	–2.24	–2.22	–2.14
20000	–0.81	–0.87	–0.93	–0.83
Detection distance (m)	0.7	0.5	1.1	0.9
Go/No go	Go	Go	Go	Go

Note: The bottom 2 rows list predicted-detection distances from the ADM and whether the predicted distances meet Level II aural-nondetectability requirements outlined in MIL-STD-1474E. "Go" represents meeting the MIL-STD-1474E requirements and "No go" represents not meeting the MIL-STD-1474E requirements.

Table A-16 Measurements for the 455G NVG in the "low" lighting level listing each 1/3-octave band level

Analyzed 1/3 octaves (Hz)	Measurement angle (°)			
	0	**90**	**180**	**270**
25	23.99	29.47	28.31	26.82
31.5	24.54	27.41	22.42	24.08
40	20.32	21.58	16.90	18.10
50	22.95	22.19	18.74	18.78
63	19.36	19.77	16.68	16.85
80	10.42	14.56	10.45	12.09
100	6.92	7.63	9.52	9.62
125	5.00	1.88	6.44	5.82
160	–7.17	–8.26	–2.71	–7.61
200	–9.05	–10.18	–6.44	–11.23
250	11.05	–8.63	–8.32	–12.18
315	11.40	–12.23	–9.35	–12.73
400	10.83	–12.25	–10.41	–12.68
500	11.59	–12.27	–11.74	–12.22
630	11.56	–11.69	–11.25	–12.22
800	11.62	–11.85	–10.93	–11.75
1000	10.79	–10.92	–10.39	–11.08
1250	10.05	–10.21	–9.85	–10.29
1600	–8.26	–8.89	–8.83	–9.32
2000	8.88	5.44	1.31	–0.28
2500	17.03	13.35	9.03	7.33
3150	–4.14	–5.52	–5.67	–5.36
4000	–4.97	–5.44	–5.04	0.00
5000	–4.61	–4.22	–4.15	–4.36
6300	–3.03	–3.31	–3.11	–2.56
8000	2.28	–1.96	–2.56	–2.40
10000	–1.13	–0.86	–1.32	–0.76
12500	0.23	–0.35	–1.34	–0.06
16000	1.40	0.96	–0.05	2.92
20000	8.13	1.45	–0.19	6.09
Detection distance (m)	5.83	3.86	2.44	1.99
Go/No go	Go	Go	Go	Go

Note: The bottom 2 rows list predicted-detection distances from the ADM and whether the predicted distances meet Level II aural-nondetectability requirements outlined in MIL-STD-1474E. "Go" represents meeting the MIL-STD-1474E requirements and "No go" represents not meeting the MIL-STD-1474E requirements.

Table A-17 Measurements for the 455G NVG in the "mid" lighting level listing each 1/3-octave band level

Analyzed 1/3 octaves (Hz)	Measurement angle (°)			
	0	**90**	**180**	**270**
25	24.96	31.13	28.29	29.85
31.5	25.36	29.29	23.58	25.57
40	21.27	24.49	19.40	18.79
50	21.22	23.30	22.70	19.16
63	19.69	20.57	19.61	16.95
80	11.22	14.50	12.58	12.23
100	7.75	8.07	10.62	9.22
125	6.31	3.66	6.56	6.39
160	–4.20	–6.63	–3.39	–7.19
200	–6.56	–8.75	–3.19	–11.01
250	–8.26	–9.02	–6.83	–11.93
315	–9.80	–11.86	–9.76	–12.19
400	–8.47	–11.77	–9.63	–12.23
500	–8.69	–12.01	–9.57	–11.80
630	10.78	–11.60	–10.08	–12.10
800	11.48	–11.53	–10.56	–11.66
1000	10.74	–11.11	–9.97	–10.96
1250	–9.99	–10.14	–9.48	–10.17
1600	–8.54	–9.00	–8.48	–9.13
2000	7.72	5.16	0.90	0.06
2500	15.81	13.06	8.54	7.68
3150	–4.83	–5.56	–5.53	–5.34
4000	–4.51	–5.27	–4.98	–2.41
5000	–4.71	–4.40	–4.09	–4.67
6300	–2.90	–3.53	–3.17	–2.46
8000	3.53	–1.87	–2.50	–1.40
10000	–1.21	–0.92	–1.55	–0.78
12500	–0.46	–0.37	–1.42	0.22
16000	1.51	0.89	–0.09	2.81
20000	7.24	1.61	–0.32	5.82
Detection distance (m)	5.41	3.80	2.37	2.04
Go/No go	Go	Go	Go	Go

Note: The bottom 2 rows list predicted-detection distances from the ADM and whether the predicted distances meet Level II aural-nondetectability requirements outlined in MIL-STD-1474E. "Go" represents meeting the MIL-STD-1474E requirements and "No go" represents not meeting the MIL-STD-1474E requirements.

Table A-18 Measurements for the 455G NVG in the "high" lighting level listing each 1/3-octave band level

Analyzed 1/3 octaves (Hz)	Measurement angle (°)			
	0	**90**	**180**	**270**
25	27.21	29.75	28.90	27.77
31.5	23.54	26.96	23.31	28.59
40	20.82	23.13	18.39	21.21
50	20.92	21.96	21.38	20.65
63	16.63	21.71	18.37	18.21
80	10.38	14.43	12.41	13.58
100	4.49	8.34	8.32	17.31
125	6.33	8.21	4.09	11.43
160	–7.85	–7.40	–5.68	–0.76
200	11.49	–10.71	–9.21	–2.60
250	10.37	–9.63	–9.47	–5.38
315	12.46	–11.69	–11.37	–7.50
400	12.13	–11.50	–11.66	–4.54
500	12.61	–11.67	–11.06	–7.13
630	–9.44	–9.87	–10.36	–10.67
800	–0.38	–6.17	–9.62	–6.44
1000	–8.41	–9.75	–9.12	–9.16
1250	–9.05	–9.35	–5.51	–5.26
1600	–8.78	–7.89	–4.19	–2.27
2000	3.44	0.85	7.16	10.86
2500	10.91	4.71	1.75	2.56
3150	–4.99	–5.16	–3.50	–3.21
4000	–4.73	–2.48	–1.11	–2.43
5000	–4.61	–4.24	–2.72	–0.44
6300	–3.34	–3.45	–1.68	–1.85
8000	–1.13	–0.59	0.08	1.46
10000	–1.75	–1.99	–1.73	–0.78
12500	–0.96	–1.19	–1.23	–0.02
16000	0.77	0.38	0.03	0.79
20000	9.30	0.35	–0.26	3.37
Detection distance (m)	3.01	1.47	1.69	2.69
Go/No go	Go	Go	Go	Go

Note: The bottom 2 rows list predicted-detection distances from the ADM and whether the predicted distances meet Level II aural-nondetectability requirements outlined in MIL-STD-1474E. "Go" represents meeting the MIL-STD-1474E requirements and "No go" represents not meeting the MIL-STD-1474E requirements.

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List of Symbols, Abbreviations, and Acronyms

ACH	Advanced Combat Helmet
ADM	Auditory Detection Model
AGC	automatic gain control
ANSI	American National Standards Institute
APG	Aberdeen Proving Ground
ARL	US Army Research Laboratory
ASA	Acoustical Society of America
ASIO	audio signal in–out
ATF	Acoustic Test Fixture
CFL	compact fluorescent light
dB	decibel
DOD	Department of Defense
fc	footcandle
FOM	figure of merit
Hz	hertz
KEMAR	Knowles Electronic Manikin for Acoustic Research
kHz	kilohertz
LED	light-emitting diode
m	meter
NVG	night-vision goggle
s	second
SNR	signal-to-noise ratio
SPL	sound pressure level
W/m^2	watt per square meter

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